RELIABLE FUEL METERING

PRODUCT MANUAL
ELLISON THROTTLE BODY INJECTOR

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The ELLISON THROTTLE BODY INJECTOR IS PROTECTED BY PATENT NUMBER 4,524,034. EUROPEAN AND ASIAN PATENTS PENDING.

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SECTION 1

GENERAL INFORMATION

1-1 Introduction

This manual provides complete information for the installation, operation, and maintenance of the ELLISON Throttle Body Injector (TBI).

This device offers improved aircraft engine performance and economy when installed and operated in accordance with this manual.

> **NOTE:**
> The ELLISON TBI described herein is not FAA approved. Its use in standard category aircraft is prohibited.

1-2 Description

The ELLISON Throttle Body Injector (TBI) is a variable venturi, diaphragm controlled, fuel metering device configured to supply the fuel and air requirements of several popular aircraft engines. It will operate in any attitude and through a wide range of G-loads, making it an attractive replacement for carburetors or fuel injectors.

1-3 Application

The ELLISON TBI is available in the five models listed in Table 1-3. Adjacent to each model is a list of engines having airflow requirements compatible with that model.

Table 1-3

EFS-2	HAPI, Revmaster,Great Plains, and other VW derivatives
EFS-3	Lyc. O-235, O-290, Cont. O-200, O-300
EFS-4	Lyc. IO-320, O-320, O-340
EFS-4-5	Lyc. IO-360, O-360,
EFS-5	Lyc. O-540, Cont. O-470
EFS-10	Lyc. IO-540, Cont. IO-550

1-4 Principles of Operation

The TBI shown in cut-away in figure 1-4 is a variable venturi device in which the fuel injection always occurs in the plane of maximum airflow velocity. Fuel injection occurs through a matrix of very small metering holes located in a tube extending across the entire width of the airflow passage. Fuel is admitted to this metering tube by a demand regulator, designed to maintain a slightly negative fuel pressure in the metering tube. The metering tube is positioned in a bore through the throttle slide. Movement of the throttle slide thereby controls fuel flow as well as airflow by changing the number of metering holes exposed to the air stream.

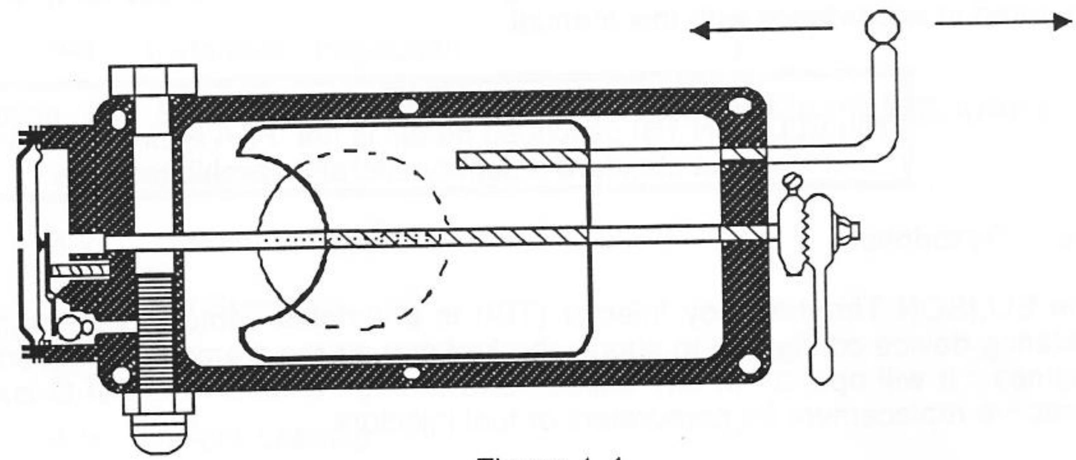


Figure 1-4

Rotation of the metering tube through a maximum angle of 90 degrees changes the orientation of the fuel metering holes with respect to the airflow. This rotation serves as the pilot's mixture control. Full lean occurs when the holes are facing directly into the on- coming airflow, and a progressively richer mixture is obtained as the holes are rotated away from the zero angle of attack position.

Because the fuel pressure in the metering tube is maintained below ambient pressure, fuel will not flow from the metering holes unless induction air is flowing through the inlet bore. This feature permits the engine to be shut down without the necessity of turning off the main fuel valve.

Idle fuel is dispensed by an idle fuel jet whose discharge rate is adjusted by a conventional needle valve. This valve is located in the regulator end of the body and is adjusted using a 5/32 inch Allen wrench.

1-5 Fuels Compatibility

The ELLISON TBI has been designed specifically for aircraft use and has been thoroughly tested with aviation fuels. Auto or agricultural fuels should **NOT** be used with the ELLISON TBI.

1-6 Performance Baseline

It is suggested that prior to beginning the installation of the TBI, the aircraft be flown through the flight test outlined in Section 5-1 of this manual steps 3 through 13 using the aircraft's original fuel metering system. Later comparison of this data with post-installation data will quantify the performance benefit or penalty resulting from the TBI installation.

In order to assure accuracy, it is very important that the test be flown in smooth air, preferably in the morning. It is also important that the aircraft be properly trimmed and allowed several minutes of hands-off level flight to stabilize its speed before any performance data is recorded.

SECTION 2

INSTALLATION

2-1 Planning

Because of the many differences between the TBI and the aircraft's original fuel metering system, it is very important to carefully plan the routing of all linkages, plumbing, and ducting before beginning the permanent installation.

Like other diaphragm fuel metering systems such as the Bendix PS-5 carburetor and the Bendix RSA-5 Fuel Injector, the TBI will experience momentary power loss when momentary interruptions in fuel flow occur. This can result from the formation of vapor or the ingestion of air from leaks in the fuel system.

Below is a list of potential vapor or air leak sources that should be considered during the planning phase of any TBI installation.

1. Boost pump, gascolator, fuel filter, and fuel valve should preferably be located outside the engine compartment or mounted together and blast cooled.
2. Boost pump should be located below the level of the fuel in the tanks.
3. Fuel lines in the engine compartment should be insulated by fire sleeve and protected from radiant heat sources (exhaust pipes) by reflecting baffles.
4. Minimize the number of fuel line fittings especially 90 degree elbows, and minimize the length of the fuel line especially in the engine compartment.
5. Maintain constant upward slope of fuel line from the boost pump (i.e. avoid high points or loops where air bubbles can accumulate).
6. On aircraft with improperly baffled fuel tanks, the fuel tank pick-up can become unported allowing air bubbles to enter the fuel line. In such cases, long slips and sharp taxi turns before takeoff should be avoided while operating with low fuel tank levels.
7. Avoid the use of auto fuel.
8. Avoid fuel system complications which invite errors in fuel management.
9. Loose fittings, deffective O rings, split flares or improperly installed components such as primer pumps and gascolator seals can be a troublesome source of air leaks and areusually difficult to identify.

2-2 Installation Requirements

In order for the ELLISON TBI to perform satisfactorily and dependably, the finished installation must include the following features:

A. Inlet air filter

B. Induction air heat system

C. Cockpit throttle stops, open and closed

D. Cockpit mixture control stops, rich and lean

E. Fuel filter, 70 micron or finer

F. Fuel pump with 2 to 6 psi output pressure for all units except the EFS-10 which requires 12 to 18 psi.

> NOTE:
> The Bendix RSA-5 fuel injection system and PS-5 pressure carburetor use fuel pumps with output pressures of 20 and 15 psi respectively. Such pressure may be incompatible with standard TBI configurations.

G. Induction system primer

H. The aircraft fuel system, up to the point of connection to the TBI, including lines, filters, pumps, valves, and fuel flow sensors, must demonstrate the capability of flowing 150% of the rated power fuel requirements of the engine when operating on the last gallon of fuel in the tank. This flow capacity must exist when the aircraft is at the pitch attitude yielding minimum fuel head and with the fuel boost pump operating.

I. Fuel tank vents in all tanks

2-3 Mounting

Because the ELLISON TBI uses a diaphragm in lieu of a float chamber, the unit may be mounted in nearly any position. There are a few positions which should be avoided if possible.

When mounting the unit in a horizontal or "side draft" orientation, avoid any position which puts the fuel metering tube in the vertical or near vertical plane. Positive or negative "G" forces acting on the diaphragm will alter fuel metering.

2-4 Fuel Inlet Fitting

The TBI body contains a double ended fuel inlet chamber which has a 9/16-18 female thread at each end. The fuel inlet fitting with attached filter may be installed in either end of this chamber. The opposite end contains an AN-814-6D plug. The TBI fuel inlet fitting is compatible with standard 3/8 inch tube fittings found in most aircraft fuel systems.

The inlet filter (Fig. 6-0, item #2) is a 150 mesh stainless steel finger screen which is quite fragile and must be handled with care when removed. Great care should also be exercised to avoid the introduction of contaminants into the housing when removing and replacing the inlet screen or the plug. Installation of the inlet fitting as well as the AN-814-6D plug (Fig. 6-0, item #8) into the TBI body requires the application of 75 to 120 in-lbs of torque. The fuel inlet screen is a "last chance" filter; therefore, the aircraft fuel system must include a primary filter of 70 micron rating or finer.

> NOTE:
> If contaminants are found inside the TBI inlet filter screen, then a failure of the main airframe filter has occurred and must be corrected.

> CAUTION
> Do not use thread sealing compounds or tape. All fitting joints use either an "O" ring seal or a flared tube seat and, if properly installed, require no additional sealing material.

An optional fuel inlet fitting incorporating a 90 degree elbow is available on special order.

2-5 Throttle Linkage

During engine operation at less than full throttle, a substantial pressure difference exists between the two ends of the throttle slide. This pressure gradient causes a strong buoyancy force acting to close the throttle. This force is greatest at idle and diminishes at increased throttle openings.

> CAUTION
> In the event of any throttle linkage failure allowing unrestrained throttle movement, the engine will immediately and without hesitation, return to idle.

Because of the higher throttle friction associated with the TBI, linkage installations utilizing a pull cable in only one direction with spring return in the opposite direction are not satisfactory.

Throttle Body Injector models EFS-4, EFS-4-5, EFS-5 and EFS-10 may be configured with their throttle control arms and fuel fittings located on either side of the body as illustrated in Fig. 2-5.1. Customer preference for these two options must be specified when ordering. **The Model EFS-3 is only available with throttle configuration A.**

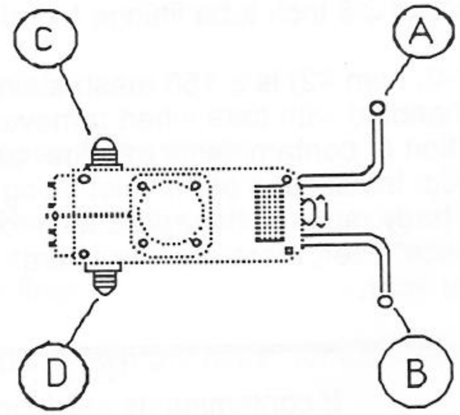


Figure 2-5.1

Throttle linkage connection to the TBI throttle control arm must provide movement which is parallel to the throttle control arm within plus or minus 5 degrees. This requirement may be met using a bell crank arrangement such as the one illustrated in Figure 2-5.2 or a push-pull cable or rod as illustrated in Figure 2-5.3. The throttle control arm is supplied with a ball-swivel fitting containing a 10-32 female thread for connection to a pushrod or Morse cable end.

Throttle linkages which utilize a push-pull cable may have the cable housing secured to the TBI by an optional EFS cable clamp (Fig. 6-0, item # 26) illustrated in figure 2-5.3

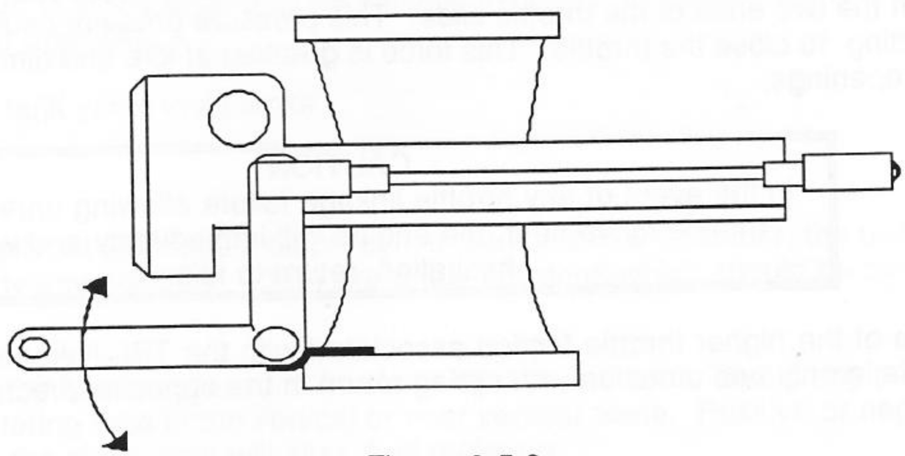


Figure 2-5.2

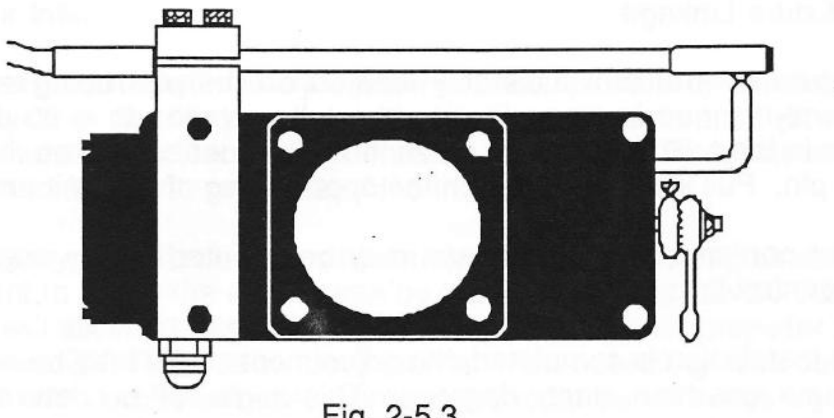


Fig. 2-5.3

NOTE:
Maximum throttle control arm extension at full throttle for the various models is as follows:

EFS-10	2.4 inches
EFS-5	2.0 inches
EFS-4-5	1.875 inches
EFS-4	1.750 inches
EFS-3	1.625 inches

Additional allowance must be made for engine movement on mounts to assure no interference with other parts of the engine or airframe components.

Following installation and hook up of the throttle linkage to the TBI throttle control arm, the cockpit mounted "open throttle" stop must be adjusted so that the cockpit throttle control contacts the stop concurrent with, or prior to, the slide reaching its full open position. This stop is required to prevent excessive pilot force being applied to the throttle control arm.

Adjustment of the "throttle closed" stop will be described in Section 3-4 of this manual.

2-6 Mixture Linkage

The mixture control arm assembly located on the protruding end of the metering tube is permanently pinned in place limiting the tube rotation to a 90 degree angle. The mixture control is in the full rich position when the adjustment screw on the mixture limit arm contacts the stop pin. Full lean occurs when the opposite leg of the limit arm contacts the pin.

The outer portion of the control arm may be oriented at any angle for compatibility with the mixture control linkage.

After the installation is completed, the adjustment screw may be adjusted to limit the travel to some angle less than ninety degrees. This angle will be determined in Section 3-2 of this manual.

2-7 Induction Heat

Contrary to common belief, **the ELLISON TBI can accumulate ice**! Additionally, engines with cold induction manifolds such as the four cylinder Continental engines, the Continental O-470, and all Volkswagen derivative engines are especially susceptible to the formation of manifold ice. FOR THESE REASONS, ALL TBI INSTALLATIONS **MUST** INCLUDED AN INDUCTION HEATING SYSTEM. Follow engine or airframe manufacturer's recommendations for use of induction heat.

2-8 Protection from Engine Heat

Air temperatures in the engine compartment downstream of the cylinders are usually about the same as the engine's oil temperature. Fuel system components such as filters, gascolators, boost pumps etc, when located in this high temperature environment can easily heat the fuel to its boiling temperature. While float carburetors separate vapor and discharge it through the float bowl vent, the TBI, like other diaphragm controlled fuel metering devices, pass this vapor on to the engine, resulting in roughness, power loss or power instability.

Vapor problems can be avoided by :

1. Locating filters, gascolators and boost pumps outside of the engine compartment,
2. Insulating engine compartment fuel line with fire sleeve
3. Blast cooling the engine driven fuel pump. If it is not possible to mount these components remotely, then they should be enclosed together in a box or shroud and blast cooled.

2-9 Induction Air Inlet

Fuel metering in the Ellison Throttle Body Injector is accomplished by sensing both the direction and velocity of air flowing past the metering tube. This means that engine performance can be adversely affected if air entering the Throttle Body Injector is extremely turbulent or is delivered from only one side of the inlet bell mouth.

In general, the efficiency of the induction air inlet can be judged by engine smoothness at full throttle and the extent to which the engine can be leaned at cruise power. An inlet with good flow characteristics will allow an engine equipped with a fixed pitch propeller to run smoothly with the mixture leaned 200 RPM below peak power when operating at or below 75% power. An engine equipped with a constant speed propeller should demonstrate smooth operation when leaned to peak exhaust gas temperature while operating at or below 75% power.

> CAUTION:
> Severe engine damage can result from operation above 75% power with an excessively lean mixture. At a pressure altitude of 7000 feet, the engine produces only about 75% power at full throttle and can tolerate leaner mixtures. Consult the engine manufacturer's operating manual for proper leaning procedures for fuel injected engines.

2.9.1 Good Inlet Configurations

Fig. 6-1 through 6-3 of Appendix D, illustrate good inlet configurations. These promote excellent cylinder to cylinder fuel distribution because air enters the Throttle Body Injector inlet uniformly from 360 degrees around the inlet centerline.

2.9.2 Inlet Configurations to be Avoided

Inlet configurations such as shown in Fig. 6-4 and 6-5 of Appendix D, require intake air to undergo a sharp 90 degree bend while entering the Throttle Body Injector, causing some of the metered fuel to be deflected against the throat wall. Full throttle operation will be rough due to poor fuel distribution, and the engine will have little tolerance for operation on lean mixtures at cruise power settings.

Some configurations which do allow 360 degree air delivery like the one shown in Fig. 6-6 of Appendix D, will experience problems at full throttle due to the short vertical distance between the Throttle Body injector and the opposite air filter flange. This configuration promotes the formation of a standing vortex in the inlet bell mouth, reducing the airflow capacity of the Throttle Body Injector with resulting full throttle roughness and loss of power.

16. If the engine does not start by the fifth compression stroke, return to step 11. If step 11 has been repeated three times or if symptoms of flooding occur, refer to Section 4-4 Unloading. Then return to step 12.

17. If the engine runs at a normal idle RPM and then dies after consuming the prime fuel, turn the idle mixture screw (Fig. 6-0 item # 5) 1/2 turn counter clockwise and begin again at step 11.

18. If the engine runs at very low RPM and then dies, increase the idle throttle opening by rotating the idle throttle stop screw (Fig. 6-0, item # 40) clockwise as necessary to obtain stable operation.

> NOTE:
> Fine tuning the idle adjustment is described in Section 3-4 and will be done after the engine has been thoroughly warmed up by operation at full power.

19. Both Magneto switches to **OFF** position at all times except when engine is being started or is running.

3-2 Maximum Throttle Adjustment

Due to variations in engine installation, it may be necessary to limit the full throttle opening. For example, turbulent intake air entering the TBI from a short radius elbow may cause the engine to loose power at the full open position. Also, a highly pitched prop might limit engine RPM to a point that the engine does not require the maximum throttle opening. In both instances, the engine could likely produce more power if the throttle opening is closed slightly.

The following steps should be followed only if it is determined that the engine runs rough, loses power, or is excessively lean at the full throttle position.

1. Secure the aircraft with tie-downs and wheel chocks.

2. If an absolute pressure manifold pressure gauge is installed, note the reading that occurs prior to engine start. If a manifold vacuum gauge is installed, confirm that the gauge reads "zero" prior to engine start.

3. Start the engine and run at low power until the engine is properly warmed.

4. Slowly open the throttle until the manifold pressure gauge reads 1 to 1.5 inch of mercury less than the pre-start reading. If a manifold vacuum gauge is used, slowly open the throttle until the manifold vacuum reads 1 to 1.5 inch of mercury.

5. While the throttle is locked in the position established in step 4 above, adjust the mixture control to provide peak RPM.

6. With the mixture control secured in the peak RPM position, confirm that the manifold pressure or vacuum gauge reading is unchanged from step 4.

7. Mark, measure, or otherwise note the throttle position so that this position can be reset following engine shutdown.

8. Return the throttle to idle.

9. After sufficient cool down, kill the engine by turning off the ignition.

10. Adjust the cockpit throttle stop to the position established in step 7.

11. Start the engine and confirm that the throttle stop limits the throttle opening as specified in step 4.

3-3 Full Rich Adjustment

The following procedure should be carried out with all inlet ducting removed. Because the engine will be operated at full open throttle, a piece of 1/16 " mesh screen should be secured over the bellmouth to prevent the ingestion of foreign debris.

1. The aircraft must have its tail tied down and wheel chocks must.be in place.

2. Start the engine and run at low power and full rich mixture until the engine is properly warmed.

3. Run the engine briefly at full throttle and adjust the mixture control to 50 RPM drop on the rich side of peak RPM (or 200 degrees F on the rich side of peak EGT if a constant speed propeller is installed).

4. While the mixture control remains fixed in the position.established in step 3, return the throttle to idle.

5. After sufficient cool down at idle, kill the engine by turning the magneto or ignition switch to **OFF**.

6. With the engine off, adjust the full rich mixture stop on the TBI.(Fig. 6-0, item # 46) to the position established in step 3.

7. If the mixture stop screw does not have adequate travel to stop metering tube rotation at the position in step 3, then a stop may be installed on the pilot's mixture control or some other location in the mixture linkage.

8. Install the air filter and all inlet ducting, repeat steps 1 and 2, then run the engine briefly at full throttle. Confirm setting established in step 3, and make additional adjustment if required. If roughness occurs at full throttle with all inlet ducting in place, then excessive inlet turbulence is indicated. Consult section 2-9 regarding inlet duct design or limit full throttle opening in accordance with section 3-2 of this manual.

3-4 Idle Adjustment

The following procedure requires that the cockpit mixture control be placed in the full rich position, and that the engine oil temperature be at least 100 degrees F.

1. Start the engine and set the throttle to the desired idle RPM.

2. If the engine is running with excessive richness or leanness, correct by adjusting the idle mixture screw (Fig.6-0, item # 5). Clockwise to lean and counter clockwise to enrich.

3. Adjust the idle throttle stop screw (Fig. 6-0, item #40) as necessary to get desired idle RPM.

4. Adjust the idle mixture screw to give peak RPM; then enrich to decrease speed by 25 to 50 RPM.

5. If idle RPM is different than desired, return to step 2. Several iterations through steps 2 through 4 may be required.

6. Following completion of the above, the engine should run at the desired RPM with the mixture control in the full rich positions. Movement of the mixture control to the full lean position should cause the engine to increase its speed 25 to 50 RPM before decreasing.

7. Accelerate the engine from 1000 RPM to full power by sudden throttle movement to wide open. If the engine stumbles or hesitates, then the idle mixture must be enriched.

8. Operate the engine at full throttle and exercise the mixture control to confirm full rich operation is 50 RPM or 200 degrees F. EGT on the rich side of peak. If not, then repeat steps 3 through 6 of Section 3-3.

9. Safety wire the idle throttle set screw.

3-5 Installation Completion

1. Use safety wire or cotter keys as appropriate to secure the following:

   A. Fuel filter housing plug (Fig. 6-0, item # 8).

   B. Idle throttle set screw (Fig. 6-0, item # 40).

   C. Ball swivel fitting on throttle arm (use supplied snap ring).

   D. Throttle cable clamp screws (Fig. 6-0, item # 27).

   E. The regulator cover should still contain the factory installed safety wire and lead seal.

   F. Both ends of pressure reference tubing (Fig. 6-0, item # 54).

2. Install all remaining induction system components.

3-6 Installation Inspection

After the TBI installation is completed in accordance with the preceding sections of this manual, it should be inspected by an A&P or someone having equivalent technical expertise in aircraft fuel systems. This independent second party inspection will minimize the chance of some unsafe condition remaining undetected. Following the visual inspection, the inspector should observe a ground run from idle to full static RPM, watching for fuel leaks, excessive exhaust smoke or any other indications of unusual engine behavior. Any discrepancies must be corrected prior to proceeding with the first flight (Section 5).

Following engine shutdown, inspect the engine, TBI, and all associated plumbing, linkage, and ducting for signs of chafing, interference or leakage.

Following completion of the above inspection, install the cowling and any other items necessary for final airworthiness.

Make appropriate entries in the aircraft log books and consult with the FAA regarding any requirements they may have for revising the aircraft's operating limitations.

SECTION 4

STANDARD OPERATING & MAINTENANCE PROCEDURES

4-1 General

This section outlines the procedures to be used in normal operation of the ELLISON TBI after the unit has been installed and adjusted in accordance with the preceding sections of this manual. If any instruction or procedure specified in this section conflicts with recommendations of the aircraft or engine manufacturer, then those recommendations should take precedence over contrary instructions contained herein.

4-2 Normal Starts

The following starting procedure should be used for the engine's first start of the day and any time the engine has cooled to ambient temperature.

1. Both magnetos **OFF.**
2. Master switch **ON.**
3. Brakes **ON**, wheel chocks in place or tail tied down.
4. Mixture **FULL RICH.**
5. Throttle cracked 1/8 inch.
6. Prime the engine in accordance with the engine manufacturer's instructions.
7. Magneto switches positioned as recommended by the engine manufacturer for engine starting.
8. Engage the starter or commence manual propping.
9. If the engine does not start by the fifth compression stroke, return to step five. If symptoms of flooding occur or step five has been repeated three times, then proceed to Section 4-4 (Unloading).
10. When then engine starts, switch magnetos to **BOTH ON** and set the throttle to the desired RPM.

4-3 Hot Starts

When the engine is warm, use the same procedure as for normal starts, except omit the use of prime fuel (step 6).

> NOTE:
> Hot starts are sometimes more easily accomplished if the engine is shut down using the magneto switches rather than the mixture control.

4-4 Unloading

If during starting attempts the engine becomes overloaded with fuel, the induction system may be cleared as follows:

1. Both magnetos **OFF.**
2. Throttle **FULL OPEN**.
3. Mixture control at **FULL LEAN.**
4. Manually rotate the engine backwards through 20 blades.
5. Close the throttle and initiate the appropriate starting procedure once again.

4-5 Inflight Leaning

The ELLISON TBI provides improved fuel distribution when compared to conventional aircraft carburetors. For this reason, the common practice of leaning to the threshold of engine roughness may place a TBI equipped engine far on the lean side of safe operation. Therefore, follow the engine manufacturer's recommendations which rely on EGT, fuel flow, or RPM as a reference for leaning.

4-6 Engine Shutdown

The engine may be shut down by any of the following:

1. Set the mixture control to **FULL LEAN**.
2. Set the main fuel valve to the **OFF** position.
3. Turn both magneto switches to the **OFF** position.

If procedures 1 or 2 are used, both magnetos must be turned to **OFF** after the engine has stopped.

It has been observed that hot re-starts are sometimes more easily accomplished following engine shutdowns using procedure 3.

It is good practice to occasionally kill the engine with the magneto switch to determine that both magneto grounding circuits are functioning properly. A switch malfunction or an "open" P-lead will permit one or both magnetos to remain "hot", allowing the engine to continue running regardless of switch position.

> CAUTION:
> Because of residual fuel that always remains in the fuel system, there is constant danger of the engine firing if the propeller is rotated.

The main fuel valve must always be placed in the **OFF** position whenever the aircraft is to be parked or hangared.

4-7 Induction Ice

Contrary to common belief, **the ELLISON TBI can accumulate ice!** Additionally, engines with cold induction manifolds such as the four cylinder Continental engines, the Continental O-470, and all Volkswagen derivative engines, are especially susceptible to the formation of manifold ice. At idle power, icing is indicated by erratic RPM (loping after a smooth idle) or other signs of richness. This condition can be corrected with the application of induction heat. In cruise, Icing might be indicated by a gradual enrichment of mixture, or the inability to lean the engine with the mixture control. This condition can be corrected by selecting full rich mixture and applying induction heat. Additionally, any ice built up during cruise can sometimes be removed by cycling the throttle from full open to full closed and then back to the desired setting.

4-8 Hot Weather Operation

When operating in conditions of very hot ambient air temperatures with very tightly cowled engine installations, fuel vapor formation may occur causing engine roughness. This problem can usually be solved by:

1. Careful thermal insulation of all fuel lines and fuel system.
2. Air blast cooling of fuel pumps and other fuel components.
3. Installation of thermal shields to protect fuel system components from radiant heating by exhaust system.
4. Turn boost pump **ON**.

4-9 High Altitude Takeoff

When operating out of high altitude airports, takeoff power should be optimized with the manual mixture control in accordance with the aircraft or engine manufacturer's recommendations.

4-10 Maintenance and Repair

The following maintenance should be accomplished at the intervals indicated:

1. Remove and clean or replace the aircraft main fuel system filter each 50 hours of engine operation.
2. Remove and clean the TBI fuel inlet finger screen each 50 hours of engine operation. Check condition of the viton "O" ring and replace with EFS P/N 29-009 if damaged.

> CAUTION:
> Do not use thread sealing compounds or tape. All fitting joints use either an "O" ring seal or a flared tube seat and, if properly installed, require no additional sealing material.

> NOTE:
> If contaminants are found inside the fuel inlet filter screen, the source must be found and corrected.

3. Clean the inlet air filter each 50 hours of engine operation or more frequently if operated in dusty conditions.

> CAUTION:
> The ingestion of unfiltered air into the TBI can create hazardous throttle plate binding and slide seal wear.

4. After an initial period of five hours of operation, idle mixture should be checked and readjusted as needed.

Field repair or disassembly of the regulator portion of the TBI is not authorized. Removal of the lead seal will void the warranty.

SECTION 5

FIRST FLIGHT

5-1 General

The first flight must not be attempted unless every detail of the installation has been accomplished in strict compliance with this manual and the pilot is thoroughly familiar with the standard operating procedures as defined in section 4.

> CAUTION:
> If any procedure specified in this section conflicts with recommendations of the aircraft or engine manufacturer, then those recommendations should take precedence over contrary instructions contained herein.

During the first flight the pilot should have available a pencil and the flight test log sheet included as Appendix B in this manual for recording flight test data.

> CAUTION:
> If at any time during the following procedures the engine or flight instruments give readings that are outside of acceptable limits, the flight should be discontinued.

1. Preflight the aircraft in accordance with normal preflight procedures.

2. Start the engine in accordance with section 4 of this manual.

3. Complete the normal engine run up and pre-takeoff check lists. Prior to brake release, check engine instruments to determine that full takeoff power is available. The take off should be accomplished with the mixture in the full rich position and the induction heat off.

4. Climb to an altitude that is comfortable for normal cruising flight and reduce throttle to cruise power. After trimming the aircraft for hands-off level flight, allow enough time for the aircraft's speed to stabilize, then record the data requested on line 1 of the flight test log.

5. While at the same altitude and power setting as above, carefully lean the mixture to peak RPM or peak EGT if a constant speed propeller is installed. If RPM or EGT begins decreasing as the mixture is leaned, then the full rich mixture setting is too lean. Discontinue the flight and repeat section 3-3 of this manual. After 5 minutes of hands-off stabilized level flight, record the data requested on line 2.

6. While at the same altitude and power setting, slowly lean the mixture to the threshold of engine roughness. Record on line A the RPM (or EGT) at which roughness is first noticed and then return the mixture to full rich.

7. While at the same altitude as above, advance the throttle to wide open. Adjust mixture to 50 RPM (50 degrees EGT) on the rich side of peak, Trim the aircraft and allow time for the aircraft speed to stabilize. Record data required on line 3.

8. Climb to 7000 feet leaving the mixture control set as directed in step 7 above. Trim for hands-off level flight at full throttle, and allow time for speed to stabilize. Record data on line 4.

9. While at the same stabilized flight condition, lean mixture to peak RPM (EGT). Record data on line 5.

10. At the same stabilized flight condition, lean the mixture to the threshold of engine roughness. Record the RPM (EGT) at which this occurs and then enrich only as necessary, just to restore smooth operation. Record data requested on line 6.

11. Position mixture control to **FULL RICH** prior to descent.

12. After landing retard the throttle to idle while mixture is full rich.Record idle RPM on line B.

13. With brakes on, and tail tied down, set the engine speed at 1000 RPM and perform a "jam" acceleration. Note behavior on line C of the test flight log.

Following completion of the above test, fill out all remaining portions of the flight test log sheet. The original should remain with the aircraft log book and **a copy must be returned to Ellison Fluid Systems, Inc.** A close-up photograph of the completed EFS installation as well as a stand-off photograph of the aircraft in its ready-to-fly configuration would be appreciated.

APPENDIX A

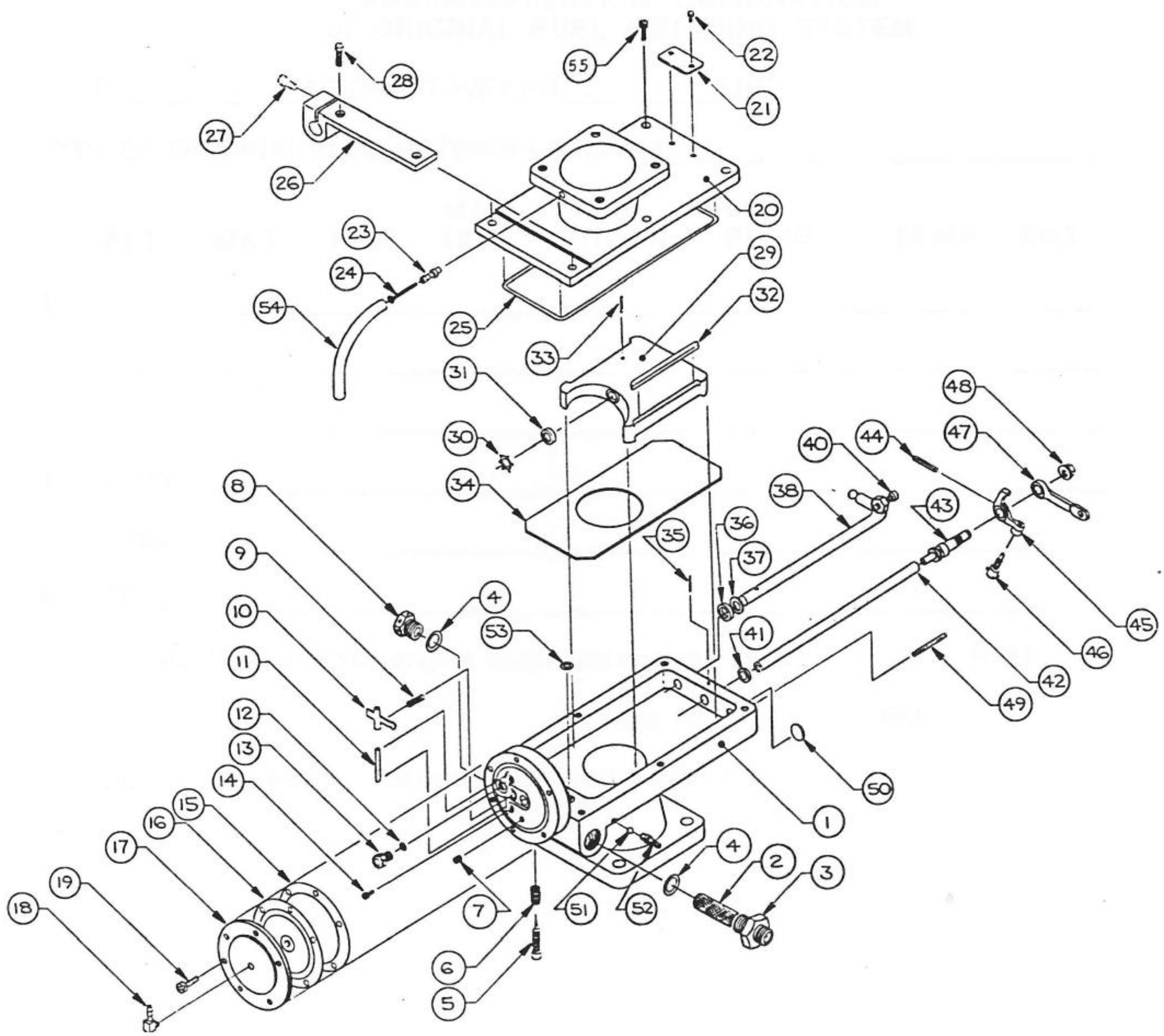


Fig. 6-0

APPENDIX B

FLIGHT TEST LOG SHEET

PRE-INSTALLATION CALIBRATION of ORIGINAL FUEL METERING SYSTEM

DATE______________AIRCRAFT WEIGHT____________LBS

TYPE OF ORIGINAL FUEL METERING SYSTEM____________________________________

	ALT	OAT	RPM	MAN IAS	FUEL PRESS.	OIL FLOW	TEMP	EGT
1.								
2.								
3.								
4.	7000							
5.	7000							
6.	7000							

A. Record RPM at which engine roughness occurs: Step 6____________RPM

Step 10____________RPM

B. Describe acceleration behavior observed in step 12:

FLIGHT TEST LOG SHEET

POST-INSTALLATION CALIBRATION
of ELLISON THROTTLE BODY INJECTOR

DATE____________AIRCRAFT WEIGHT__________LBS

TBI MODEL NUMBER:____________SERIAL NUMBER:____________

	ALT	OAT	RPM	MAN IAS	FUEL PRESS.	OIL FLOW	TEMP	EGT
1.								
2.								
3.								
4.	7000							
5.	7000							
6.	7000							

A. Record RPM at which engine roughness occurs: Step 6__________RPM
Step 10_________RPM

B. Describe acceleration behavior observed in step 12:

C. Aircraft type:______________ N#______ A/C Builder & OWNER__________

D. Engine Model:__________Propeller:________Fuel Pump type & P/N_________

E. Engine time-TT:__________SMOH:____________

Engine installation includes which of the following features?

( ) Induction Heat
( ) Air Filter
( ) Electric Fuel Boost Pump
( ) Manual Boost Pump
( ) Gravity Feed Fuel System
( ) Engine Primer
( ) Updraft Installation
( ) Horizontal Installation

APPENDIX C

TROUBLE SHOOTING GUIDE

SYMPTOM	POSSIBLE CAUSES
Dying at idle with engine cold	Not unusual - idle setting must be adjusted when engine is warm. Without engine heat to evaporate idle fuel, the throttle must be opened slightly until the oil warms up
Dying at idle when engine is warm on a warm or hot day but idle behavior stable on cool days or when engine is cold	Vapor formation caused by fuel lines absorbing engine heat when fuel rate is very low. This problem is common with fuel injection systems and may be prevented by: 1. Careful insulation of all fuel system components 2. Blast cooling pumps, gascolator, filter, and flow transmitter 3. Install vapor return line to tank per EFS, Inc. instructions Leak in fuel system on suction side of fuel pump allowing air to be drawn into fuel systems.
Idle setting seems to change	Throttle slipping or unsupported Ice: apply carb heat Induction air leak between TBI and cylinders Leaking throttle slide seal
Acceleration unsatisfactory	Idle mixture too lean Induction air leak between TBI and cylinders Mixture not in full rich position Metering tube holes clogged
Flat spot in throttle response when slowly opening throttle	Plugged holes in metering tube Induction air leak between TBI and cylinders
Excessively rich at idle conditions of visible moisture or high humidity	ICE - Apply induction heat

Excessive idle RPM when idle throttle adjust screw is backed out fully	Induction air leak between TBI and cylinders
Excessive leanness at high power	1. Full rich metering tube adjustment set too lean 2. Inlet air turbulence caused by bad airbox configuration. Review section 2-9 of this manual 3. Fuel system flow capacity limit (see section 2-2, item H) 4. Induction gasket or airbox flange blocking bellmouth reference probe 5. Leak in fuel system on suction side of fuel pump such as leaking primer or pump lines which allows air to be drawn into fuel system 6. Clogged fuel filter 7. Clogged metering tube holes 8. Vapor formation 9. Defective fuel pump
Leaking fuel after engine shutdown	
1. Less than 1 tablespoon	Normal
2. More than 1 tablespoon (leak continues)	This sometimes occurs on new TBI units but should disappear after fuel inlet control valves have seated (usually within the first 10 hours of operation)
Engine roughness at wide open throttle	Same cause as excessive leanness at high power
Engine dies when throttle is slowly opened from idle	Induction air leak between TBI and cylinders
Engine roughness at WOT that tends to smooth out when mixture is leaned	Inlet turbulence (see section 2-9) or rich stop set too rich
Rich idle that persists after idle mixture screw is fully seated	Indicates worn slide seals caused by ingestion of unfiltered air. Return TBI to Ellison Fluid Systems for repair

APPENDIX D

Good Inlet Designs

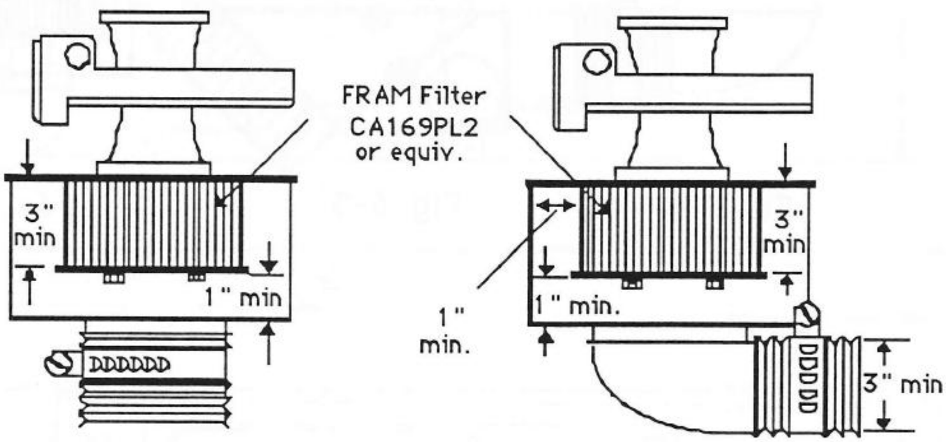


Fig. 6-1

Fig. 6-2

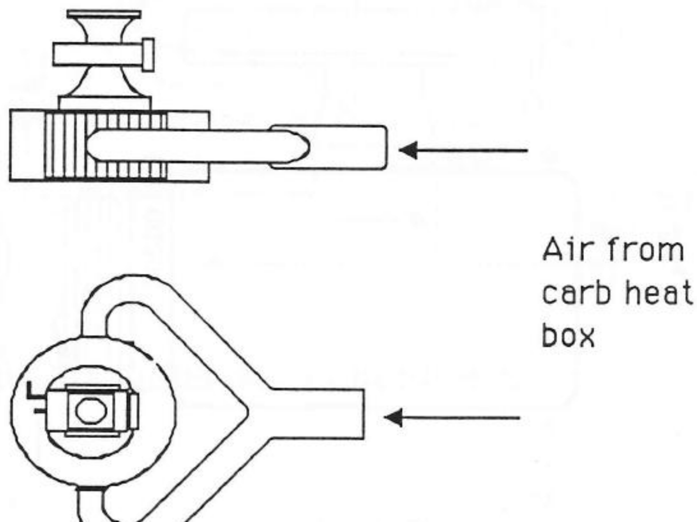


Fig. 6-3

Bad Inlet Designs

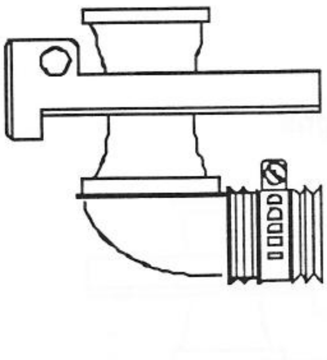


Fig. 6-4

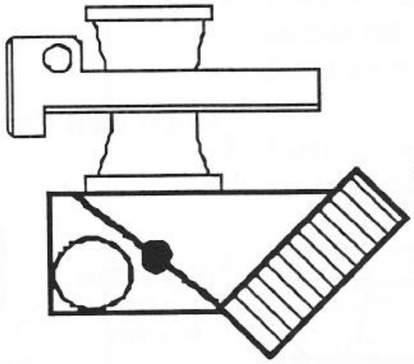


Fig. 6-5

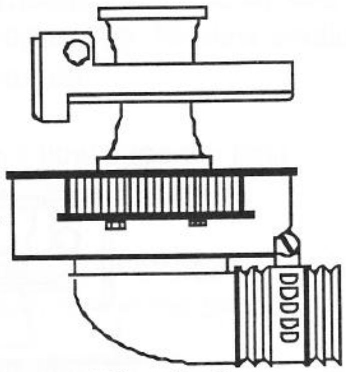


Fig. 6-6

Large volume Plenum Chamber

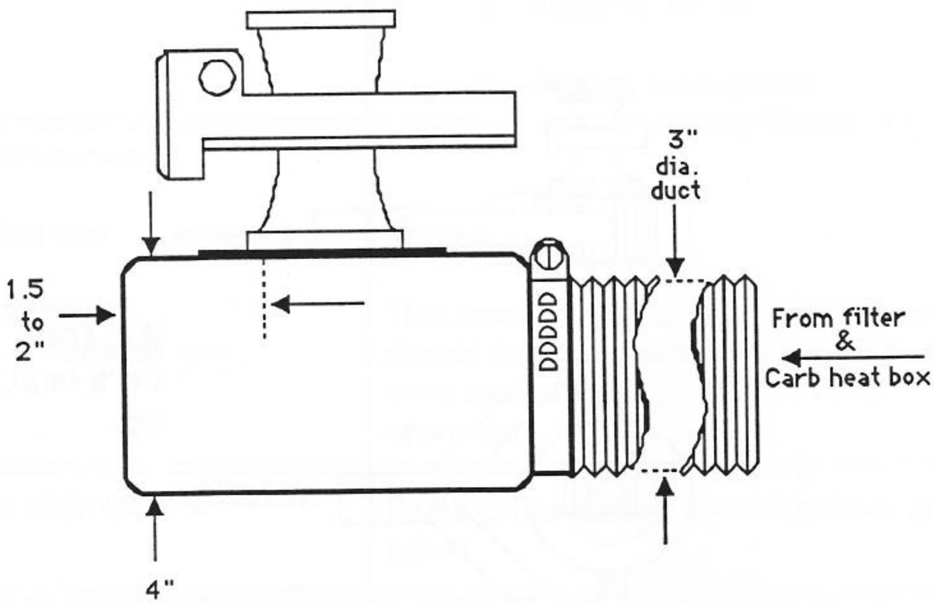
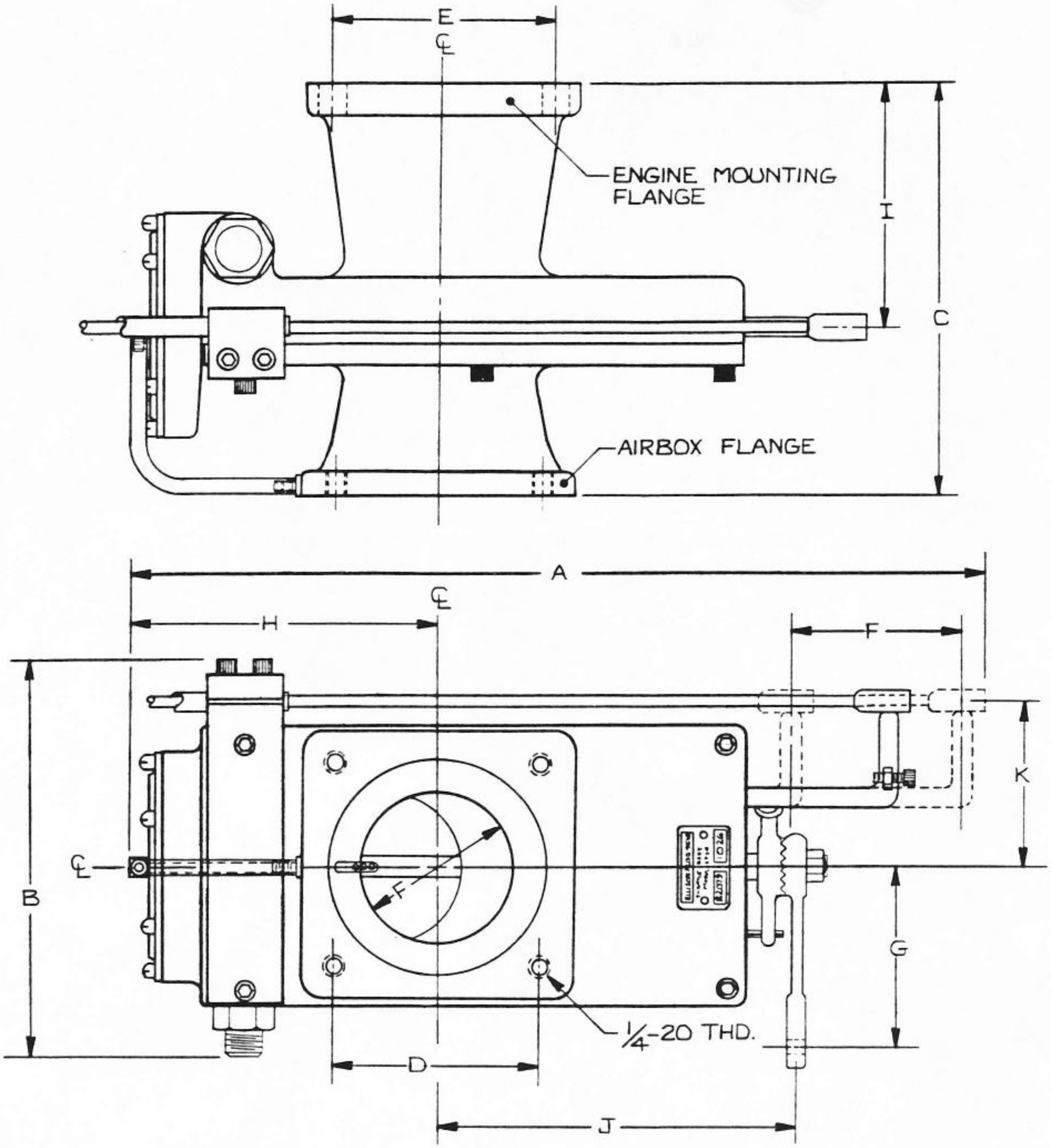


Fig. 6-7



ALL DIMENSIONS IN INCHES

	A	B	C	D	E	F	G	H	I	J	K
EFS-10	12 1/4	5 3/4	5 5/8	3 1/4	3.37	2.40	2	4 3/8	3 1/8	5	2 3/8
EFS-5	9 5/8	5 1/16	4 7/8	2 1/2	2.34	2	2	3 5/8	2 13/16	4 1/2	2
EFS-4-5	9 1/2	5 1/16	4 7/8	2 1/2	2.34	1 7/8	2	3 5/8	2 13/16	4 3/8	2
EFS-4	8 7/8	4 5/8	4 1/8	2 1/2	2.34	1 3/4	2	3 7/16	2 7/16	3 3/4	1 3/4
EFS-3	8 1/2	4 3/8	4 1/16	2 1/2	1.94	1 5/8	2	3 3/8	2 7/16	3 5/8	1 5/8
EFS-2	6 1/2	3 7/8	4 3/8	2 1/2	1.94	1.35	2	2 3/8	1 15/16	3	1 3/4